

Annubar Flow Calculation Program
(For the FloBoss™ 407 Flow Manager
and ROC300-Series Remote Operations Controller)

User Manual
(QER 01Q032)

Form A6120
January 2006

Revision Tracking Sheet

January 2006

This manual may be revised periodically to incorporate new or updated information. The revision date of each page appears at the bottom of the page opposite the page number. A change in revision date to any page also changes the date of the manual that appears on the front cover. Listed below is the revision date of each page (if applicable):

Page	Revision
All pages	Jan-06
All pages	Sep-03 (Rev 4)
All pages	Jul-03 (Rev 3)
li, 10, 13-17	Nov-01 (Rev 2)
All pages	Oct-01 (Rev 1)

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1 INTRODUCTION

1.1 Scope and Organization

This document serves as the user manual for the Annubar Flow Calculation Program (QER 01Q032), which is intended for use in a FloBoss™ 407 Flow Manager or a ROC300-Series FlashPAC unit. This manual describes how to download and configure this program (referred to as the “Annubar program” or “the program” throughout the rest of this manual). You access and configure this program using ROCLINK™ 800 Configuration Software (version 1.50 or greater) loaded on an IBM-compatible personal computer running Windows® 98, ME, NT 4.0 (with Service Pack 6), 2000 (with Service Pack 2), or XP.

The sections in this manual provide information in a sequence appropriate for first-time users. Once you become familiar with the procedures and the software running in a FloBoss 407 or ROC300-Series unit, the manual becomes a reference tool.

This manual has the following major sections:

- ◆ Section 1 – Introduction
- ◆ Section 2 – Installation
- ◆ Section 3 – Configuration
- ◆ Section 4 – Reference Materials

This manual assumes that you are familiar with the FloBoss 407 and ROC300-Series FlashPAC units and their configuration. For more information, refer to:

- ◆ *FloBoss 407 Flow Manager Instruction Manual* (Form A6013).
- ◆ *ROCLINK 800 Configuration Software User Manual* (Form A6121).
- ◆ *ROC306/312 Remote Operations Controller Instruction Manual* (Form A4630)
- ◆ *ROC364 Remote Operations Controller Instruction Manual* (Form A4193)

Note: When the text applies to both the ROC300-Series and the FloBoss 407, we use the generic term “ROC.” If differences are present, we indicate those differences by device name.

1.2 Product Overview

The Annubar Flow Calculation Program enables both ROC300-Series with FlashPAC and FloBoss 407 units to perform flow calculations for meter runs implementing an Annubar end element. The program allows the same ROC to calculate, in parallel, the Annubar flow calculations and orifice and turbine flow calculations.

The program enables the ROC to calculate volumetric flow given differential and static pressure from an Annubar end element. The program also calculates energy rate, accumulates flow and energy, and provides the ability to archive flow and energy totals in the historical database.

1.2.1 Annubar Flow Algorithm

As implemented in this program, following is the algorithm for Annubar volumetric flow rate of a gas at standard conditions:

$$Q_v = C'[h_w P_f]^{0.5}$$

Where:

Q_v = Volumetric flow rate of gas at standard conditions

h_w = Differential pressure

P_f = Absolute static pressure (flowing)

$$C' = F_{NA} * K * D^2 * F_r * Y_a * F_{pb} * F_{tb} * F_{tf} * F_{gr} * F_{pv} * F_a$$

Where:

F_{NA} = Units conversion factor

K = Annubar flow coefficient

D = Internal pipe diameter

F_r = Reynolds number factor

Y_a = Annubar expansion factor

F_{pb} = Pressure base factor

F_{tb} = Temperature base factor

F_{tf} = Flowing temperature factor

F_{gr} = Specific gravity factor

F_{pv} = Supercompressibility factor

F_a = Thermal expansion factor

The calculation is identical to the AGA 3 (orifice) calculation with the following exceptions:

Basic Orifice Factor (F_b) - The AGA 3 calculation defines the basic orifice factor as follows:

$$F_b = 338.178d^2K_o$$

Where:

d = Orifice diameter

K_o = The flow coefficient when the orifice Reynolds Number is infinitely large.

This is roughly equivalent to the first three factors in the Annubar equation. The value 338.178 is equivalent to the F_{NA} factor in the Annubar equation to convert the flow to units of SCFH. The square of the orifice diameter (d^2) has been replaced with the square of the internal pipe diameter (D^2) and the flow coefficient (K) is the actual flow coefficient determined from Table 2.1 of the Annubar Flow Handbook, rather than the coefficient at an infinitely large Reynolds Number (K_o). The result of multiplying $F_{NA} * D^2 * K$ is stored in the F_b parameter.

Reynolds Number Factor (F_r) - Because the flow coefficient in the Annubar equation is the actual flow coefficient, the Reynolds number factor is not required and will always equal 1.0.

Expansion Factor (Y) - The expansion factor for Annubars is calculated as follows:

$$Y = 1 - ((1-B)^2 0.011332 - 0.00342) h_w / P_f k$$

$$B = 4d / \pi D$$

Where:

B = Blockage factor

D = Internal pipe diameter

d = Annubar diameter

h_w = Differential pressure

P_f = Absolute static pressure (flowing)

k = Ratio of specific heats (1.3 for gases)

Supercompressibility (Fpv) – The compressibility factor is calculated using the method defined in the meter run setup.

All of the calculated factors, referenced above, may be viewed in softpoint parameters when the softpoint enable flag is set to a valid softpoint number. See Section 4.1 for a description and location of values written to the softpoint.

1.3 Program Requirements

You download the Annubar program to—and then run it from—the Flash memory on the ROC. You configure the program functions by point type and parameter using the ROCLINK 800 Configuration software. The program is compatible with version 1.10 (or greater) of the FloBoss 407 and with version 2.20 (or greater) of the ROC300-Series FlashPAC.

Based on the available memory (see Section 2.2) or other user task requirements, select one of the programs listed below. Program specifics include:

Program Name	User Task	Code Area	Data Area	UDP	ROC or FloBoss Version
FP1 ABAR.H00	User 1	D0000-D3FFF	B0000-B3FFF	30	ROC300-series FlashPAC
FP3 ABAR.H00	User 3	D8000-DBFFF	B8000-BBFFF	29	ROC300-series FlashPAC
FB1 ABAR.H00	User 1	B0000-B3FFF	60000-63FFF	30	FloBoss 407
FB3 ABAR.H00	User 3	B8000-BBFFF	70000-73FFF	29	FloBoss 407
FB4 ABAR.H00	User 4	C8000-CBFFF	74000-77FFF	29	FloBoss 407

Note: You must connect a PC to the ROC unit's LOI port before starting the download.

For information on viewing the memory allocation of user programs, refer to the *ROCLINK 800 Configuration Software User Manual* (Form A6121).

2 INSTALLATION

This section provides instructions for installing the Annubar program using version 1.50 (or greater) of the ROCLINK 800 Configuration software. Read Section 1.3 of this manual for program requirements.

2.1 Customizing ROCLINK 800

Before downloading the user program, you must apply two custom files to ROCLINK 800. This enables you to access the Annubar Calculation configuration screen.

Note: Apply this customization to ROCLINK 800 **before** you download the user program.

To apply the file:

1. Navigate to the CD-ROM folder in which the installation files are located. Custom ROCLINK 800 files are typically located in the ROCLINK Files folder on the CD-ROM.
2. Select and copy the following two files:
 - ◆ Annubar Calc Pt 29.DSP.
 - ◆ Annubar Calc Pt 30.DSP.
3. Paste the files into the default ROCLINK Displays folder. This is typically C:\Program Files\ROCLINK800\Displays. This completes the customization.

2.2 Downloading the Program

This section provides instructions for installing the user program into the Flash and ROM memory on the ROC.

To download the user program:

1. Connect the ROC to your computer using the LOI port.
2. Start and logon to ROCLINK 800.
3. Select **Utilities > User Program Administrator** from the ROCLINK menu bar. The User Program Administrator screen displays:

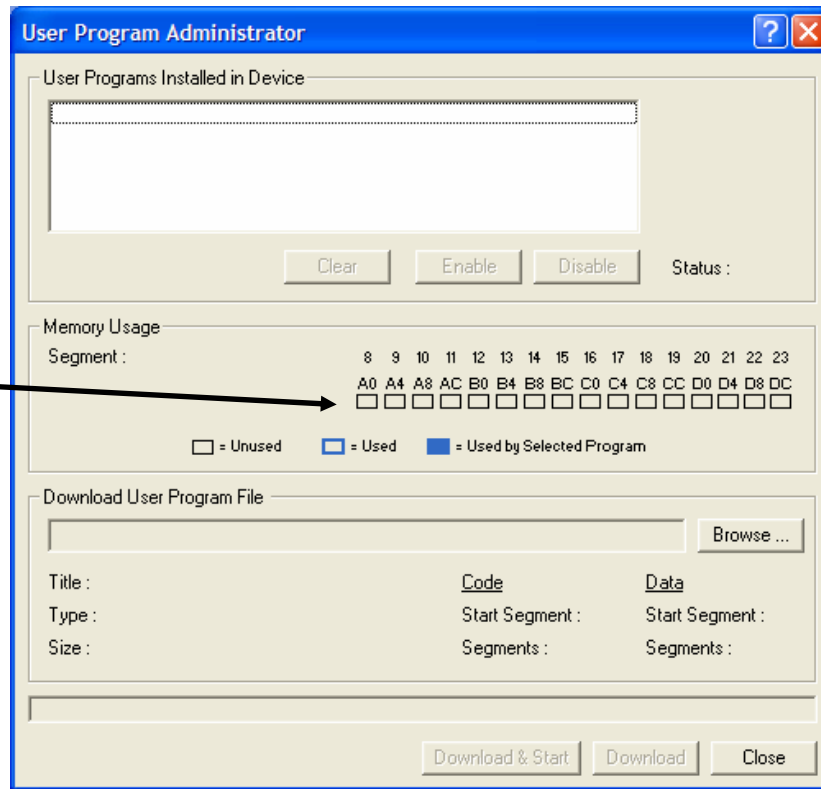


Figure 1. User Program Administrator Screen

- Review the screen, paying special attention to the Memory Usage frame and the unused memory blocks display.

Field	Description
User Programs Installed in Device	This display-only frame identifies any programs currently installed in the ROC. The program provides this name during installation.
Status	This display-only field indicates the current status of the program. Valid values are ON or OFF .
Memory Usage	This display-only frame shows the current memory allocation by segment. Note: You must have the following sufficient available (non-allocated) memory in order to successfully load the Annubar program:

For the FloBoss 407 (version ≥1.10) load one of the following:

Program Name	COMM Port	Code Area	Data Area
FB1_ABAR.H00	User 1	B0000-B3FFF	60000-63FFF
FB3_ABAR.H00	User 3	B8000-BBFFF	70000-73FFF
FB4_ABAR.H00	User 4	C8000-CBFFF	74000-77FFF

For the ROC300-Series (version ≥2.20) load one of the following:

Program Name	COMM Port	Code Area	Data Area
FP1_ABAR.H00	User 1	D0000-D3FFF	B0000-B3FFF
FP3_ABAR.H00	User 3	D8000-DBFFF	B8000-BBFFF

Note: Contact your sales representative if you **cannot** load the program due to current memory block usage.

Field	Description
Download User Program File	This display-only frame identifies the programs you have selected for download, along with the Code and Data segment information (see Figure 3).

- Identify (based on your device and current memory allocations) the appropriate program to use.
- Click **Browse** in the Download User Program File frame. The Select User Program File screen displays (see Figure 2).
- Select the path and user program file to download from the CD-ROM. (Program files are typically located in the Program Files folder on the CD-ROM). As Figure 2 shows, the screen lists all valid user program files with the .H00 extension:

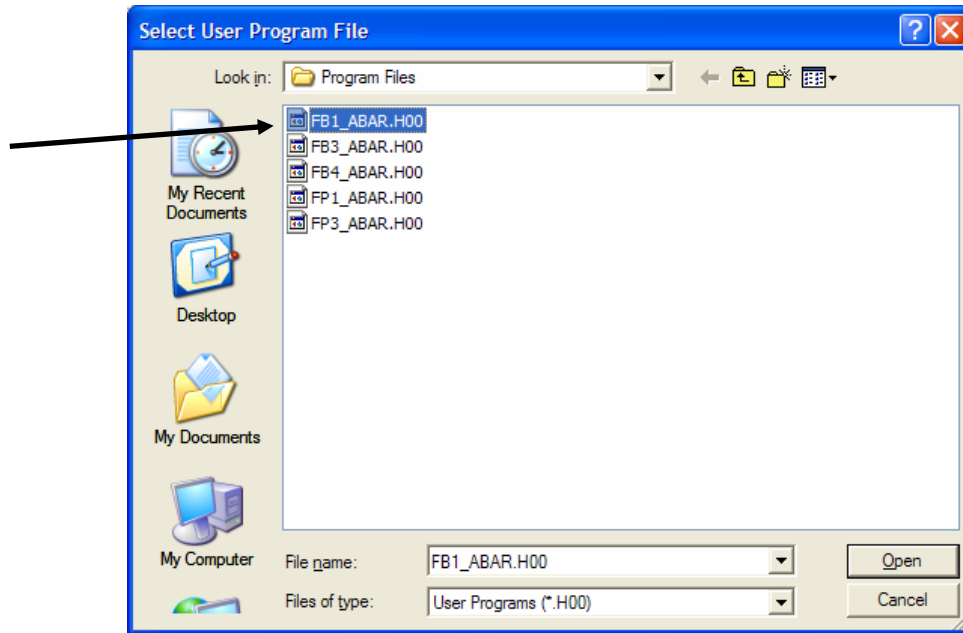


Figure 2. Select User Program File

- Click **Open** to select the program file. The User Program Administrator screen displays. As shown in Figure 3, note that the Download User Program File frame identifies the selected program and that the **Download & Start** button is active:

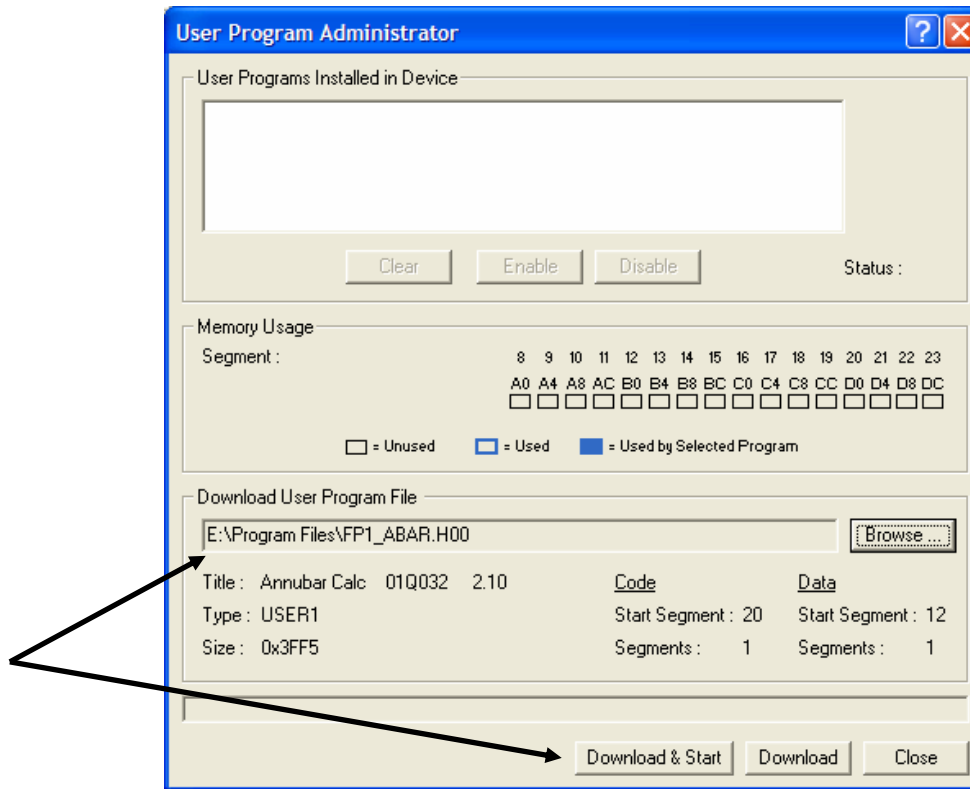


Figure 3. User Program Administrator Screen

- Click **Download & Start** to begin loading the selected programs. The following message displays:

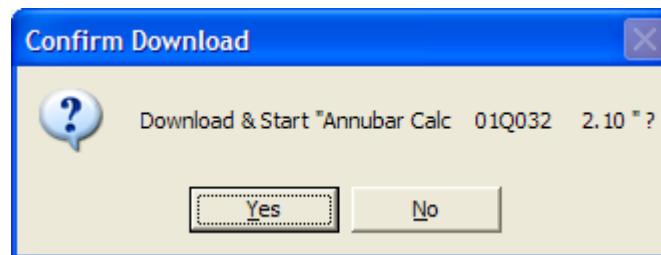


Figure 4. Confirm Download

- Click **Yes** to begin the download. During the download, the program performs a Warm Start, creates an event in the Event Log, and—when the download completes—displays the following message:

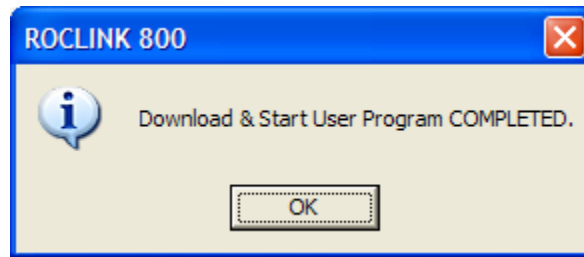


Figure 5. ROCLINK 800 Download Confirmation

Note: If you are running ROCLINK 800 version 1.50 or earlier, the following warning may display. Click **OK** to continue.

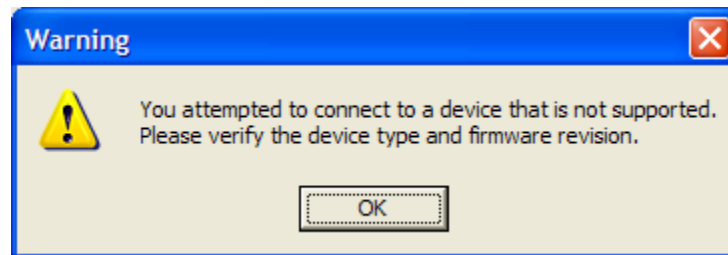


Figure 6. Device Type and Firmware Warning

11. Click **OK**. The User Program Administrator screen displays (see Figure 7). Note that:

- ◆ The User Programs Installed in Device frame identifies the installed program.
- ◆ The Memory Usage frame reflects the use of system memory.
- ◆ The message *Download & Start User Program COMPLETED* appears at the bottom of the screen.

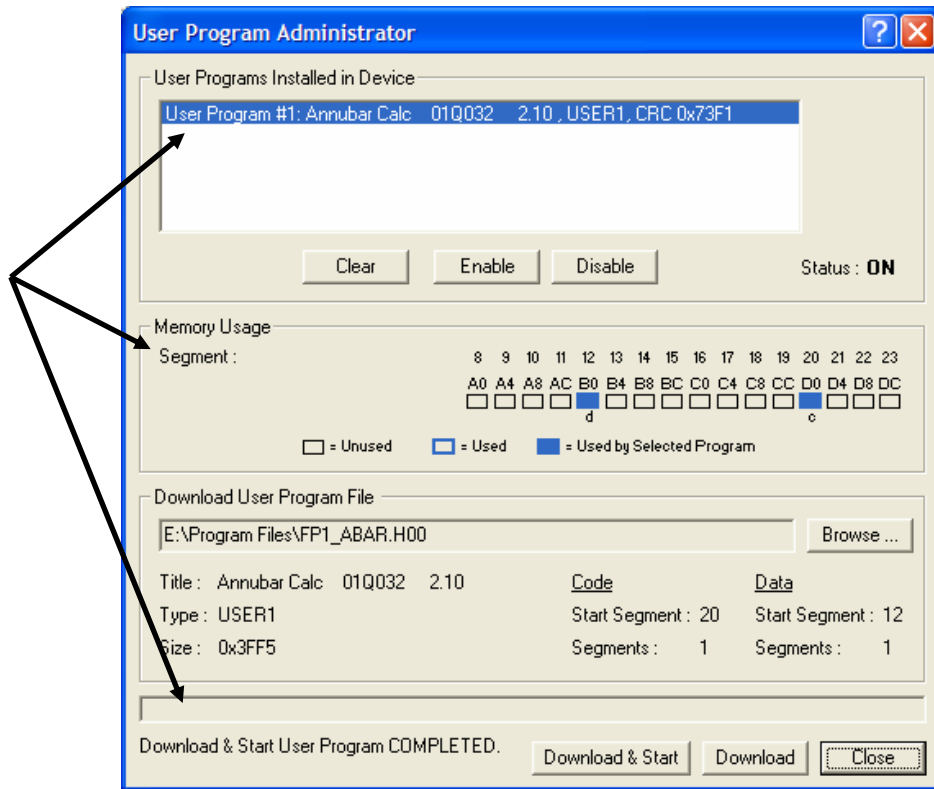


Figure 7. User Program Administrator Screen

12. Click **Close**. The ROCLINK 800 screen displays and the download is complete.

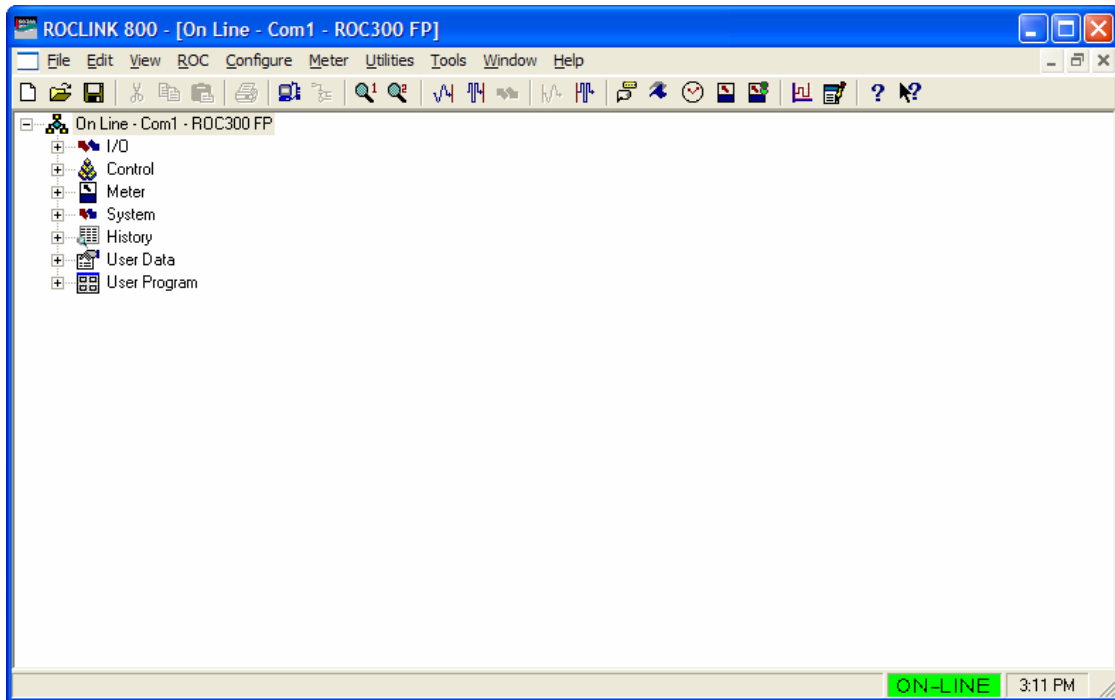


Figure 8. ROCLINK 800 Screen

3 CONFIGURATION

After you have successfully downloaded the Annubar program, you configure the program using the ROCLINK 800 software.

Note: This program uses the standard ROC meter run point types. You configure all meter run setup—with the exception of enabling the Annubar calculation itself—through the standard ROCLINK meter configuration screens (including general meter setup, input definitions, advanced setup, gas quality, and history setup configuration for the meter run).

To access the Annubar Calculation configuration screen:

1. From the ROCLINK 800 menu bar, select **Configure > User Data > Annubar Calc Pt.** The Annubar Calculation configuration screen displays (see Figure 10).

Note: You can also access the Annubar Calculation configuration screen using the configuration tree on the left side of the screen. Click the + next to the User Data option, click the + next to the Annubar Calc option, and then double-click the meter run you want to configure.

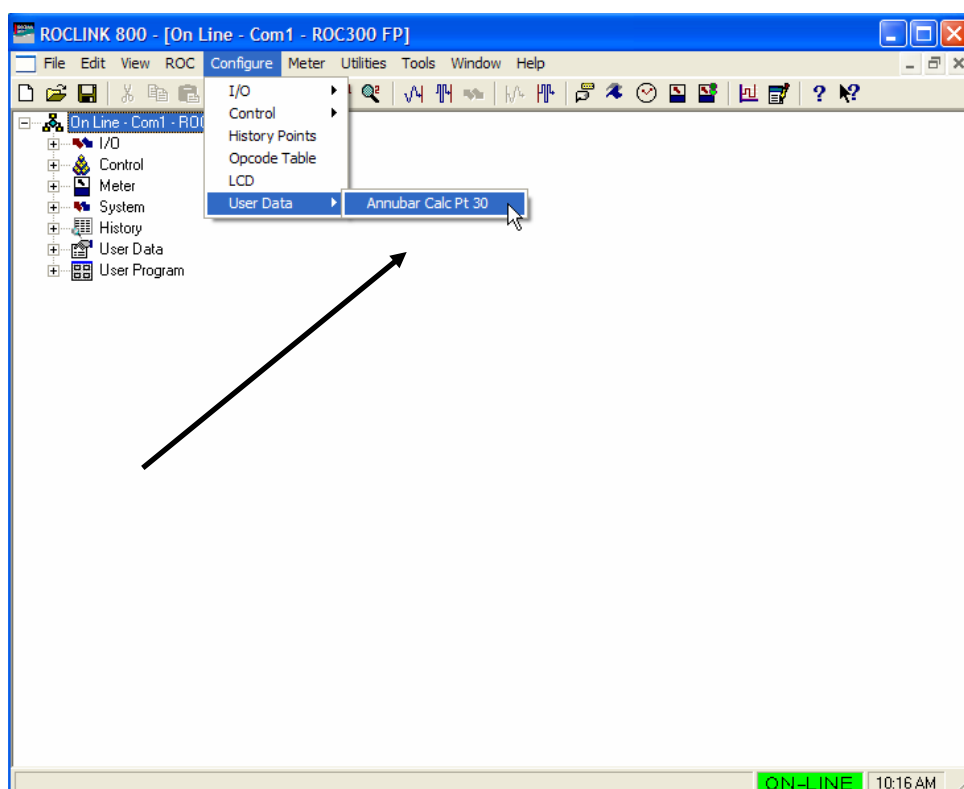


Figure 9. ROCLINK 800

2. Complete the program's configuration (refer to Section 3.1) based on your organization's requirements.

Note: If the screen shown in Figure 10 does not display, you have not correctly customized ROCLINK 800. Refer to Section 2.1.

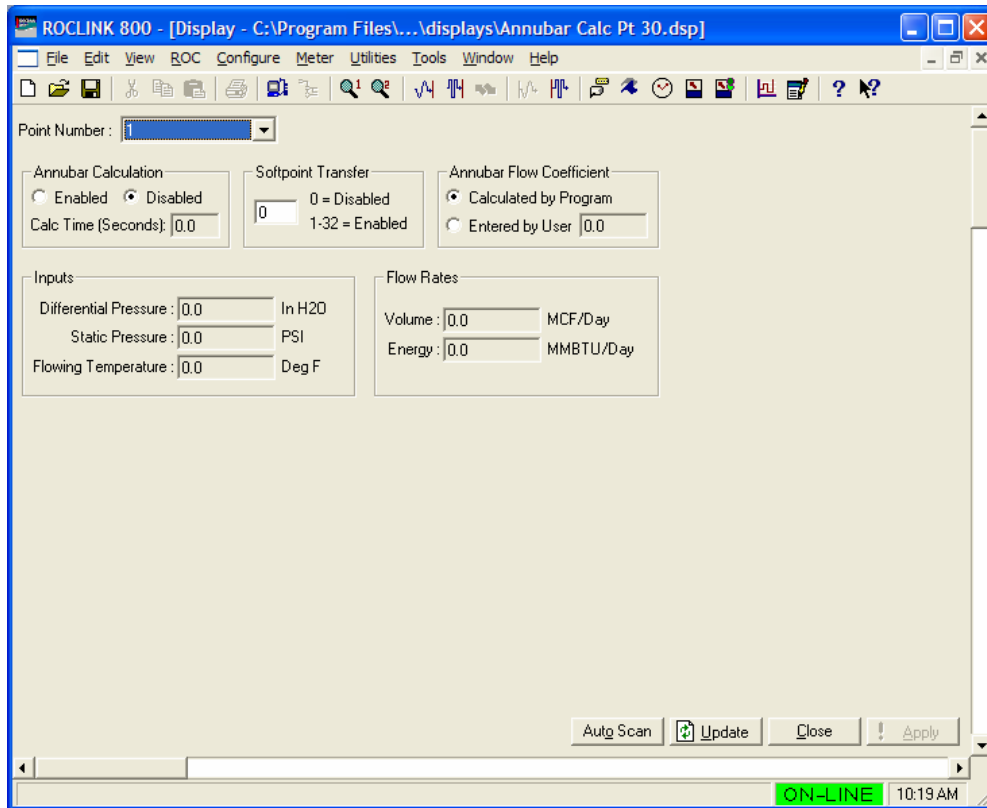


Figure 10. Annubar Calculation Configuration

3.1 Annubar Calculation Configuration Screen

Use this screen to set the calculation specifics.

1. From the ROCLINK 800 menu bar, select **Configure > User Data > Annubar Calc Pt.** The Annubar Calculation configuration screen displays.

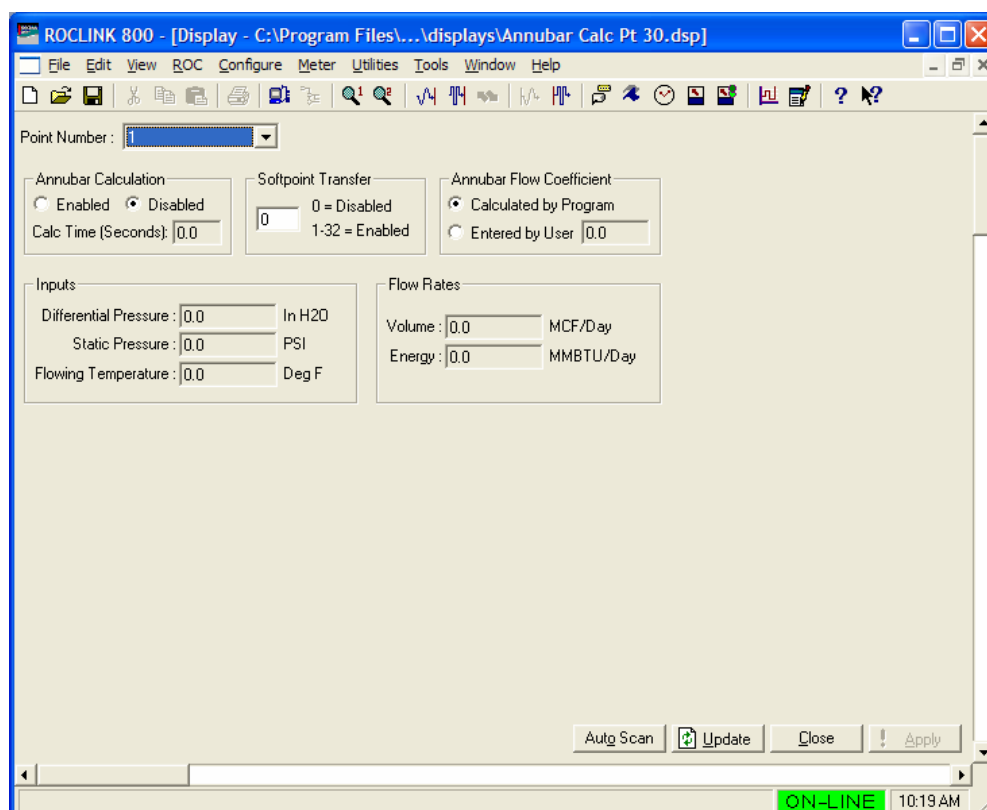


Figure 11. Annubar Calculation Configuration screen

2. Review—and change as necessary—the values in the following fields:

Field	Description
Point Number	Selects the meter run to configure. The number of available meter runs varies by device: 3 in the ROC306/312, 4 in the FloBoss 407, or 5 in the ROC364.
Annubar Calculation	Applies the Annubar calculation for this meter run. Valid values are Enabled (which activates the calculation) or Disabled (which deactivates the calculation). When you disable the Annubar calculation, the ROC executes the AGA flow calculation for the meter run. Note: You can configure Annubar, orifice, and turbine type meter runs in any combination on the ROC.
Calc Time (Seconds)	This read-only field monitors, in seconds, the period during which the program performs the Annubar calculations (reading inputs, calculating instantaneous rates, and updating accumulations) for the meter.
Softpoint Transfer	Identifies the softpoint to which the program copies flow calculation data (which a host system or FST can subsequently access). Valid values are 0 (disable the softpoint write) or 1 to 32 (allow the write to the specific softpoint). Note: Refer to Section 4.1 for a description and location of the data written to the designated softpoint.

Field	Description
Annubar Flow Coefficient	Indicates whether the program determines the flow coefficient value for the Annubar calculation or uses a value you enter. Click the appropriate radio button. Note: If you select Entered by User , you must enter the flow coefficient value in the provided field.
Differential Pressure	This read-only field displays, in inches of H ₂ O, the value of differential pressure used for the Annubar flow calculation.
Static Pressure	This read-only field displays, in PSI, the value of static pressure used for the Annubar flow calculation.
Flowing Temperature	This read-only field displays, in degrees F, the value of flowing temperature used for the Annubar flow calculation.
Volume	This read-only field displays the instantaneous flow (in MCF/day) for the Annubar flow calculation. Note: You can view other calculated flow parameters (such as today's flow or yesterday's total) from the ROCLINK I/O Monitor screen (View > I/O Monitor or Meter > Values).
Energy	This read-only field displays the instantaneous energy (in MMBTU/day) for the Annubar flow calculation. Note: You can view other calculated flow parameters (such as today's flow or yesterday's total) from the ROCLINK I/O Monitor screen (View > I/O Monitor or Meter > Values).
Auto Scan/ Stop Scan	Enables/disables automatic refresh of the information on the screen at a one-second interval.
Update	Refreshes all information on the screen.
Close	Closes the window and returns to the ROCLINK 800 screen.
Apply	Writes data entered on the screen for use in the program.

- Click **Apply** to save any changes. Go to Section 3.2.

3.2 Saving the Configuration

Whenever you modify or change the configuration, it's a good practice to save the final configuration to non-volatile memory. To save the configuration:

1. Select **ROC > Flags**. The Flags screen displays:

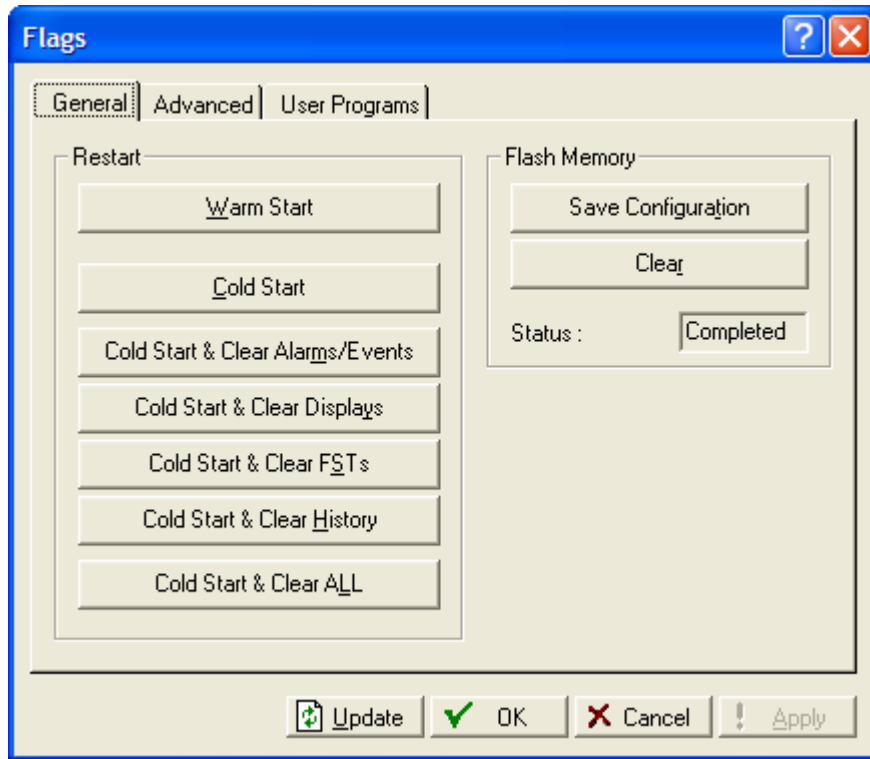


Figure 12. Flags screen

2. Click **Save Configuration**. A verification message displays:

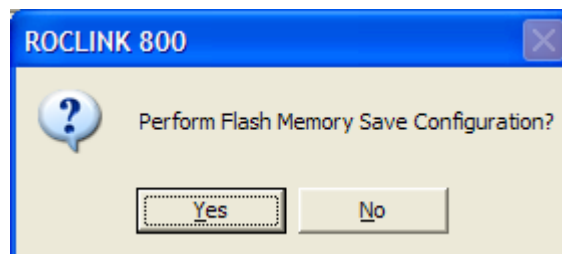


Figure 13. Perform screen

3. Click **Yes**. A confirmation message displays:



Figure 14. Flags screen

4. Click **OK** to begin the save process. The Status field on the Flags screen displays *In Progress*.

Note: Depending on the size and complexity of the user program, this process may take several minutes. When the process ends, the Status field on the Flags screen displays *Completed*.

5. Click **Update** on the Flags screen. This completes the process of saving your new configuration.

4 REFERENCE MATERIALS

4.1 Softpoint Parameters

The following table identifies the units of measure associated with each input and output of the steam calculation program.

Table 1. Annubar Calculation Program Softpoints

Parameter	Description
Data 1	Differential pressure (Inches H ₂ O)
Data 2	Static pressure (PSI)
Data 3	Flowing temperature (Deg F)
Data 4	Flow rate (MCF/DAY)
Data 5	Energy rate (MMBTU/DAY)
Data 6	Pressure Extension (HwPf)
Data 7	Correction Factor (C')
Data 8	Calculation period (Seconds)
Data 9	Annubar flow coefficient (K)
Data 10	Expansion factor (Y)
Data 11	Base pressure factor (Fpb)
Data 12	Base temperature factor (Ftb)
Data 13	Flowing temperature factor (Ftf)
Data 14	Specific gravity factor (Fgr)
Data 15	Compressibility factor (Fpv)
Data 16	Thermal expansion factor (Fa)
Data 17	Basic orifice factor (Fb)
Data 18	Intermediate variable (Forif)
Data 19	Intermediate variable (Ky)
Data 20	Diameter ratio (beta)

4.2 Annubar User Defined Points

For User Task 1, the point type is 30. For User Task 3 or User Task 4, the point type is 29.

Table 2. Annubar Flow Calculation User Defined Points

Parameter Number	Read-Write	Data Type	Length	Description
0	R/W	Byte	1	Annubar calculation enable
1	R/W	Byte	1	Softpoint write enable
2	R/O	Float	4	Differential pressure
3	R/O	Float	4	Static pressure
4	R/O	Float	4	Flowing Temperature
5	R/O	Float	4	Flow rate (MCF/DAY)
6	R/O	Float	4	Energy rate (MMBTU/DAY)
7	R/O	Float	4	Pressure Extension (HwPf)
8	R/O	Float	4	Correction Factor (C')
9	R/O	Float	4	Calculation period (Seconds)
10	R/W	Byte	1	Calc/Enter flow coefficient flag
11	R/W	Float	4	Annubar flow coefficient (K)
12	R/O	Float	4	Expansion factor (Y)
13	R/O	Float	4	Base pressure factor (Fpb)
14	R/O	Float	4	Base temperature factor (Ftb)
15	R/O	Float	4	Flowing temperature factor (Ftf)

Parameter Number	Read-Write	Data Type	Length	Description
16	R/O	Float	4	Specific gravity factor (Fgr)
17	R/O	Float	4	Supercompressibility factor (Fpv)
18	R/O	Float	4	Thermal expansion factor (Fa)
19	R/O	Float	4	Basic orifice factor (Fb)
20	R/O	Float	4	Intermediate variable (Forif)
21	R/O	Float	4	Intermediate variable (Ky)
22	R/O	Float	4	Diameter ratio (beta)

4.3 Annubar Pipe ID and Flow Coefficients (K)

Following are reference tables for Annubar probe diameters (D). Use the actual probe diameter if not listed.

Table 3. Annubar Probe Diameters

Model	Diameter (d)
10	0.183
15/16	0.3576
25/26	0.846
35/36	1.23
45/46	1.98

Table 4. Pipe ID and Flow Coefficients: Type 10

Nom Pipe Size, Inch	Schedule	Pipe ID	K
1/2	40	0.622	0.4265
3/4	40	0.824	0.5067
1	80	0.957	0.5547
	40	1.049	0.5547
1-1/4	80	1.278	0.587
	40	1.36	0.587
1-1/2	80	1.5	0.603
	40	1.61	0.603
2	80	1.939	0.6197
	40	2.067	0.6197

Table 5. Pipe ID and Flow Coefficients: Type 15/16

Nom Pipe Size, Inch	Schedule	Pipe ID	K
2	XX-STG	1.503	0.5627
	160	1.689	0.5746
	80	1.939	0.5865
	-	2	0.5888

Nom Pipe Size, Inch	Schedule	Pipe ID	K
2-1/2	40	2.067	0.5912
	XX-STG	1.771	0.5789
	160	2.125	0.5932
	80	2.323	0.599
	40	2.469	0.6026
	-	2.5	0.6033
3	XX-STG	2.3	0.5984
	160	2.624	0.6059
	80	2.9	0.6109
	-	3	0.6124
	40	3.068	0.6134
	XX-STG	2.728	0.6079
3-1/2	80	3.364	0.6172
	-	3.5	0.6187
	40	3.548	0.6192
	XX-STG	3.152	0.6146
	160	3.438	0.618
	80	3.826	0.6216
4	-	4	0.6233
	40	4.026	0.6235
	XX-STG	4.063	0.6237
	160	4.313	0.6255
	80	4.813	0.6285
	-	5	0.6295
5	40	5.047	0.6297

Table 6. Pipe ID and Flow Coefficients: Type 25/26

Nom Pipe Size, Inch	Schedule	Pipe ID	K
4	XX-STG	3.152	0.548
	80	3.826	0.5704
	-	4	0.5747
	40	4.026	0.5753
5	XX-STG	4.063	0.5762
	160	4.313	0.5814
	80	4.813	0.5901
	-	5	0.5928
	40	5.087	0.5934
6	XX-STG	4.987	0.5926
	160	5.189	0.5953
	80	5.761	0.6018
	-	6	0.6014
	40	6.065	0.6047

Nom Pipe Size, Inch	Schedule	Pipe ID	K
8	160	6.813	0.6105
	XX-STG	6.875	0.611
	80	7.625	0.6155
	40	7.981	0.6173
	-	8	0.6174
10	160	8.5	0.6196
	80	9.564	0.6236
	X-STG	9.75	0.6242
	-	10	0.6249
	40	10.02	0.625
12	160	10.126	0.6253
	80	11.376	0.6285
	X-STG	11.75	0.6293
	40	11.938	0.6297
	STD	12	0.6298
14	80	12.5	0.6308
	X-STG	13	0.6317
	40	13.124	0.6319
	STD	13.25	0.6319
	-	14	0.6332
16	80	14.314	0.6337
	40	15	0.6346
	STD	15.25	0.6349
	-	16	0.6357
18	80	16.126	0.6359
	X-STG	17	0.6368
	STD	17.25	0.637
	-	18	0.6377
20	80	17.398	0.6371
	X-STG	19	0.6385
	STD	19.25	0.6387
	-	20	0.6392
24	X-STG	23	0.641
	STD	23.25	0.6411
	-	24	0.6415
30	X-STG	29	0.6434
	STD	29.25	0.6435
	-	30	0.6437
36	X-STG	35	0.645
	STD	35.25	0.645
	-	36	0.6452
42	X-STG	41	0.6461
	STD	41.25	0.6461
	-	42	0.6462

Table 7. Pipe ID and Flow Coefficients: Type 35/36

Nom Pipe Size, Inch	Schedule	Pipe ID	K
12	160	10.126	0.6116
	80	11.376	0.6165
	X-STG	11.75	0.6178
	40	11.938	0.6184
	STD	12	0.6186
14	80	12.5	0.62
	X-STG	13	0.6214
	40	13.124	0.6217
	STD	13.25	0.622
	-	14	0.6238
16	80	14.314	0.6245
	40	15	0.6259
	STD	15.25	0.6263
	-	16	0.6276
18	80	16.126	0.6278
	X-STG	17	0.6292
	STD	17.25	0.6296
	-	18	0.6306
20	80	17.938	0.6305
	X-STG	19	0.6318
	STD	19.25	0.6321
	-	20	0.6329
24	80	21.564	0.6344
	S-STG	23	0.6355
	STD	23.25	0.6357
	-	24	0.6363
30	X-STG	29	0.6392
	STD	29.2503	0.6393
	-	30	0.6396
36	X-STG	35	0.6415
	STD	36.25	0.6416
	-	36	0.6418
42	X-STG	41	0.6431
	STD	41.25	0.6432
	-	42	0.6434
48	-	48	0.6445
60	-	60	0.6461
72	-	72	0.6472
84	-	84	0.6479
96	-	96	0.6485

If you have comments or questions regarding this manual, please direct them to your local sales representative or contact:

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